

## RESEARCH ARTICLE

# Comparison of rest-break interventions during a mentally demanding task

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## Abstract

Research is scarce on ways to enhance the effect of rest breaks during mentally demanding tasks. The present study investigated the effectiveness of two rest-break interventions on well-being during an academic lecture. Sixty-six students (53 females, mean age 22.5 years) enrolled in two different university classes of 4-hr duration participated in the study. Two measures of well-being (fatigue and vigor) were assessed immediately before, after, and 20 minutes after the break. A control condition without a break as well as an unstructured break was compared with breaks either encompassing physical activity or a relaxation exercise. Compared with the nonbreak condition, the unstructured rest break led to an increase in vigor, the exercise break as well as the relaxation break both to an increase in vigor and a decrease in fatigue at 20-min post break. Compared with the unstructured break, exercise led to an (additional) increase in vigor and relaxation to an (additional) decrease in fatigue at 20-min post break. Thus, the effects of rest breaks during mentally demanding tasks can be enhanced by engaging in physical activity or relaxation exercises, with effects lasting at least as long as 20 min into the continuation of the task.

## KEYWORDS

mental fatigue, physical activity, relaxation, rest breaks, well-being

## 1 | INTRODUCTION

Working on demanding mental tasks leads to a progressive increase in fatigue. This not only affects well-being directly by increasing a sense of weariness and lack of energy but is also accompanied by an increase in the amount of effort invested in the task to be able to keep up the level of performance (Hockey, 1997). Alternatively, demanding mental tasks can lead to a decrease in the willingness to engage in the task and a deterioration of work performance, that is, a decrease in output and/or an increase in errors (Hockey, 1997). Increases in subjective and/or objective measures of fatigue have been observed for a variety of different tasks such as mental arithmetic (Hopstaken,

2015), driving (Ting, Hwang, Doong, & Jeng, 2008), data entry (Rosa & Colligan, 1988), academic tests (Ackerman & Kanfer, 2009), driving examinations (Meijman, 1997), surgery (Engelmann et al., 2011), and vigilance tasks (Warm, Parasuraman, & Matthews, 2008).

One reason for mental work to be demanding is the necessity to display at least some degree of vigilance, which is "the ability of organisms to maintain their focus of attention and to remain alert to stimuli over prolonged periods of time" (Warm et al., 2008). Vigilance has been shown to deteriorate over time, causing mind wandering, performance decrement, and fatigue (Thomson, Besner, & Smilek, 2015; Warm et al., 2008). Work-related tasks typically requiring high amounts of vigilance are, for example, air traffic control, cockpit

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monitoring, and industrial process control, apart from experimental vigilance tasks such as the Mackworth Clock. Another non work-related mental task heavily relying on vigilance is learning in an academic class (Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012). For students, the demanding nature of academic lectures has been observed in a number of variables, including an increase in perceived mental workload and mind-wandering (Young, Robinson, & Alberts, 2009) and a decrease in perceived concentration and the retention of lecture content (Risko et al., 2012; Stuart & Rutherford, 1978).

The complex association between work demands and fatigue has been addressed by two theories. According to the compensatory control theory of fatigue (Hockey, 1997, 2011), individuals increase effort to compensate for the fatigue caused by mentally demanding tasks to maintain performance. However, increased effort is associated with an activation of the sympathetic nervous system causing strain reactions such as a rise in blood pressure or in epinephrine (Schellekens, Sijtsma, Vegter, & Meijman, 2000; Wright, Patrick, Thomas, & Barreto, 2013). If fatigue exceeds a certain level and the compensatory increase in effort is insufficient or if the individual's motivation to invest effort weakens, performance deteriorates, leading to a decline in output and/or an increase in errors or accidents (Folkard & Lombardi, 2006; Hopstaken, 2015; Rosa & Colligan, 1988; Tucker, Folkard, & Macdonald, 2003). The effort-recovery model (Meijman & Mulder, 1998) introduces recovery to the model. Strain reactions associated with demanding tasks and/or increased effort are reversible during phases of recovery, thus maintaining long-term well-being. Only when recovery is insufficient and/or demands continue to be (too) high, strain reactions may accumulate and lead to a prolonged impairment of well-being and health.

In accordance with the effort-recovery model, rest breaks, that is, an interruption of the task with the aim of recovery, are a viable means to curb the increase of fatigue associated with high work demands. It is well established that rest breaks reduce fatigue and improve well-being and performance in demanding situations. Rest breaks are associated with a 5% increase of quantitative and an 8% increase of qualitative work performance, even though work time is lost to rest breaks (Wendsche, Lohmann-Haislah, & Wegge, 2016). Likewise, rest breaks have been found to reduce subjective fatigue and increase vigor both in the aftermath of the break (Hunter & Wu, 2016; Zacher, Brailsford, & Parker, 2014) and at the end of a work episode (Engelmann et al., 2011) as well as at the end of a work day (Blasche, Bauböck, & Haluza, 2017; Meijman, 1997). Additional effects of rest breaks include an improvement of learning and retention (Cepeda et al., 2009; Donovan & Radosevich, 1999) and an enhancement of problem solving (Sio & Ormerod, 2009), as well as a reduction of physical discomfort (Barredo & Mahon, 2007).

Despite these established effects of rest breaks, little is known whether the effect of rest breaks can be enhanced in any way and if so, which strategies might have the greatest impact. The present study contributes to literature by investigating these issues. Two promising strategies to manage well-being are evaluated alongside the standard unstructured rest break regarding their impact on mental fatigue: physical exercise and relaxation instructions. These strategies have been investigated extensively regarding their impact on well-being, mood, and related variables (Reed & Ones, 2006; Yeung, 1996). However, in

this research effects on fatigue in general, and effects on fatigue related to mental demands in particular, have rarely been addressed.

In the present study, these strategies are evaluated during a situation of naturally occurring mental demands: an academic class. The present study has both theoretical and practical relevance. The theoretical relevance is whether it is possible to surpass the reduction of fatigue achieved by the temporary cessation of the task, that is, by taking a break. If this is the case, the reduction of fatigue is not solely dependent on the relief from work demands but may be determined by additional factors. Knowledge of these additional factors may further our understanding of fatigue and recovery. The practical relevance is that if one of these strategies is indeed more effective than the classical rest break, this strategy could be implemented as rest-break activity in the management of well-being, fatigue, and possibly performance during demanding tasks.

### 1.1 | Effects of rest-break activities

Rest breaks in general are assumed to decrease fatigue and improve performance by enabling the organism to restore energy levels that were drained during high work demands by temporarily relieving the individual from these demands (Meijman & Mulder, 1998). Whereas work demands can require the individual to mobilize energy by increasing physiological activation, recovery can be seen as the process of down-regulating the arousal level (Zijlstra, Cropley, & Rydstedt, 2014). Following this line of thought, the major factor for recovery during a break is temporarily interrupting task engagement, thereby stopping the investment of effort for the duration of the break (Ross, Russell, & Helton, 2014). Thus, breaks should be effective when individuals cease to invest effort in the tasks on hand.

An activity potentially promoting the effect of rest breaks is psychophysiological relaxation. There are a multitude of strategies to bring about relaxation (Lehrer & Woolfolk, 1993). However, a common theme in relaxation training is to minimize effort by relieving individuals of all obligations except to follow the relaxation instructions. At the same time, relaxation training directs the individual's attention to calming physical or emotional experiences, thereby affecting physiological processes (Lang, Kozak, Miller, Levin, & McLean Jr., 1980). This approach is reflected in mood states characterized by disengagement, mental quiet, low worry, and tranquility (Marshall & Bentler, 1976; Matsumoto & Smith, 2001). On a psychophysiological level, relaxation is the opposite of the stress response, with a decrease in sympathetic activity and an increase in parasympathetic activity (Kaushik, Kaushik, Mahajan, & Rajesh, 2006; Sakakibara, Takeuchi, & Hayano, 1994). Thus, techniques inducing relaxation reduce the psychophysiological arousal generally associated with effortful task engagement and stress (Obrist et al., 1978). On a psychological level, this corresponds to the reduction of so-called tense arousal, that is, nervousness and anxiety, found in research on relaxation (Saklofske, Blomme, & Kelly, 1992). The pronounced relief of demands experienced during relaxation, combined with the decrease of stress-related arousal may enhance the process of recovery. However, with few exceptions (de Bloom et al., 2017), most studies on relaxation have focused on psychophysiological measures and mood states associated with anxiety and stress but did not investigate the effects of relaxation on fatigue or vigor.

Differences between relaxation techniques and mindfulness practices should be noted. Although there are similarities between these techniques related both to instructions as well as to psychological and psychophysiological effects (Rausch, Gramling, & Auerbach, 2006), the objectives of the two interventions differ considerably. While mindfulness practice aims at enhancing mindfulness, that is, wakefully attending to present moment sensations in a nonjudgmental way (Kabat-Zinn, 2003), relaxation aims at reducing psychological and physiological arousal. Thus, although mindfulness practice may be the more powerful tool in promoting mental health and relieving stress in the long run (Burton, Burgess, Dean, Koutsopoulou, & Hugh-Jones, 2017; Chiesa & Serretti, 2009), relaxation techniques are preferable for short-term stress reduction.

Another activity potentially enhancing the effect of rest breaks is physical activity. Several meta-analyses and numerous studies have shown that moderate physical exercise is accompanied by an acute increase in subjective vigor or energetic arousal (Reed & Ones, 2006; Steptoe & Cox, 1988; Thayer, 1987) as well as an improvement in mood (Yeung, 1996). Thereby, exercise of low intensity and a duration of up to 15 min has the largest effect on positive activated affect (i.e., vigor). The impact of exercise on mood is highest immediately following exercise and decreases thereafter, with small effects still to be seen 30-min post exercise (Reed & Ones, 2006). Several physiological as well as psychological mechanisms have been proposed to explain the effect of exercise on mood (Paluska & Schwenk, 2000; Plante & Rodin, 1990). For example, the distraction hypothesis assumes that physical exercise distracts from stressful thoughts, thereby improving mood (Paluska & Schwenk, 2000). However, this hypothesis does not readily explain the observed effects of exercise on vigor and energetic arousal. Tentatively, the latter may be associated with the increase of brain activity occurring during physical exercise (Dietrich, 2006; Herholz et al., 1987), which may counterbalance the decrease in brain activity associated with fatigue (Lim et al., 2010; Wascher et al., 2014). Specifically, exercise may enhance the synaptic transmission of neurotransmitters such as dopamine, norepinephrine, or serotonin, thereby promoting arousal and attention (Paluska & Schwenk, 2000). In line with this reasoning, exercise also has been found to improve cognitive and sensorimotor performance (Lambourne & Tomporowski, 2010; Laporte, 1966), though this is not always seen (Watling, Smith, & Horswill, 2014). Thus, moderate physical exercise is a means to enhance the sense of energy and vigor and potentially also to decrease fatigue, at least on a temporary basis.

## 1.2 | The present study

In the current study, we sought to compare different rest-break activities in regard to their effects on two subjective strain variables related to work effort, namely, fatigue and vigor. These variables were chosen to monitor relevant aspects of possible subjective changes associated with work as well as recovery from work. Fatigue refers to predominantly physical sensations of drowsiness and energy depletion as a result of effort expenditure and is thus a core variable reflecting tiring related to demanding tasks (Smets, Garssen, Bonke, & De Haes, 1995). Vigor, on the other hand, more closely reflects a motivational state of a willingness and ability to engage in tasks and thus is more closely related to performance and productivity (Thayer, 1978). Both variables have been shown to reflect distinct facets of the fatigue construct (Smets et al., 1995). Together, the two variables have previously been used in research on fatigue and recovery to capture both motivational and experiential facets of fatigue (Fritz, Lam, & Spreitzer, 2011; Hopstaken, 2015; Zacher et al., 2014). In the present study, a non-break condition was compared with an unstructured rest break at the individual's discretion and with breaks encompassing a relaxation exercise or physical activity. In addition, the two active breaks were compared with the unstructured break.

In accordance with literature, we assume that participating in class will lead to an increase in fatigue as well as a decrease in vigor, thus laying the basis for the administration of rest breaks to counteract this effect (Hypothesis 1). In accordance with the literature on rest breaks, we assume that all three types of rest breaks will lead to an immediate and delayed decrease of fatigue and an increase in vigor (Hypotheses 2a and 2b). Furthermore, we assume that breaks encompassing physical exercise or relaxation instructions will be more effective in decreasing fatigue and increasing vigor both immediately and with some delay than an unstructured rest break (Hypotheses 3a and 3b).

## 2 | METHODS

### 2.1 | Design and interventions

In four consecutive weeks, the experiment was implemented in the morning and the afternoon class of a university curriculum on health management and health promotion. Both classes consisted of lectures of 4-hr duration to ensure sufficient levels of fatigue. The study design regarding the position of the experimental rest breaks and assessments during the classes is illustrated in Figure 1. The participation

Morning class	Lecture 8:30-10:30 120'	Coffee Break 15'	Lecture 10:45-11:30 45'	Assessment 1	Exp. Break 7'	Assessment 2	Lecture 11:40-12:00 20'	Assessment 3	Lecture 12:00-12:45 45'
	Lecture 14:00-16:00 120'	Coffee Break 15'	Lecture 16:15-17:00 45'	Assessment 1	Exp. Break 7'	Assessment 2	Lecture 17:10-17:30 20'	Assessment 3	Lecture 17:30-18:15 45'

**FIGURE 1** Study design illustrating the sequence of the experimental rest breaks (Exp. Break) together with the three assessments (1 = prebreak, 2 = postbreak, and 3 = 20-min postbreak) during the academic morning and afternoon class

in the study was voluntary, participating students gave their informed consent. Codes were used to ensure the anonymity of the participants. The study was conducted by research assistants without any prior contact to the students. Three different rest breaks and one control condition without a break were studied in four consecutive, weekly classes: an unstructured rest break, a rest break comprising physical activity, and a rest break comprising relaxation. The *exercise break* consisted of 3 min of aerobic exercise including running on the spot and a variety of jumping exercises that were alternated every 30 s followed by 3 min of a variety of stretching exercises. The *relaxation break* consisted of a 6-min guided body scan exercise. Individuals were instructed to focus their attention on various body parts and functions such as feet, legs, arms, and breathing and to observe the sensations arising in those regions. In the *unstructured rest break*, individuals could do what they wanted as long as they remained seated at their desks. Rest-break instructions and assessments were conducted by a research assistant. The sequence of the four conditions was altered between the morning and the afternoon class to control for effects of order. The morning class had the following rest-break sequence: (a) control condition, (b) exercise break, (c) relaxation break, and (d) unstructured rest break; the afternoon class had the following sequence: (a) unstructured rest break, (b) relaxation break, (c) exercise break, and (d) control condition. These sequences are referred to as rest-break sequence one and two, respectively.

## 2.2 | Study participants

Study participants were students attending either a morning class (42 students) or an afternoon class (40 students) at the University of Applied Science Burgenland, Austria. Students of the morning class were attending their first semester and students of the afternoon class their third semester. Students missing in one or more of the lessons were not included in the study. Thus, the final sample was comprised of 37 students of the morning class and 29 students of the afternoon class, in sum of 66 students (13 males and 53 females) with a mean age of 22.5 years ( $SD = 5.5$ ). The classes did not differ in regard to the age ( $F(1, 64) = 0.63, p = 0.43$ ) or sex ( $\chi^2(1, N = 66) = 0.65, p = 0.54$ ) of the participants.

## 2.3 | Variables

Fatigue and vigor were assessed using two scales out of the "Eigenzustandsskala" (Nitsch, 1976), a widely used validated German questionnaire for assessing eight distinct aspects of state well-being. Individuals described their current state of fatigue and vigor ("At the moment I feel...") by rating 15 adjectives on a 6-point worded rating scale (*hardly* [1], *slightly* [2], *somewhat* [3], *quite* [4], *predominately* [5], and *completely* [6]). The score for the scale *fatigue* ("Ermuedung" in the German original) was built with the eight adjectives "rested" (reverse scored), "in need of recovery," "exhausted," "recovered" (reverse scored), "spent," "drowsy," "tired," and "weary." The individual ratings of each adjective were added, leading to a scale ranging from 8 (minimum)–48 (maximum). The scale had a good internal consistency of Cronbach's alpha ( $\alpha = 0.85$  in the present study). *Vigor* ("Anstrengungsbereitschaft") was assessed with the seven items "vigorous," "zealous," "energetic," "persistent," "able to concentrate," "active," and "eager to work" (scale

range 7–42) and had a good internal consistency of  $\alpha = 0.92$  in the present study. The correlation of the two outcome variables, vigor and fatigue, during the unstructured rest break at Assessments 1–3 was  $r_{a1} = -0.67, r_{a2} = -0.59$ , and  $r_{a3} = -0.65$  ( $p < 0.001$ ).

## 2.4 | Data analysis

Missing values on the item level were imputed before adding the item scores to calculate the final scale score. We imputed items with the mean value of this item over individuals if no more than 25% of the items per scale were missing. Overall, only 4% of the items had been omitted. Hypothesis 1 was tested with a general linear model (GLM; SPSS 24) for repeated measures. The change of vigor and fatigue from Assessment 1 to Assessment 3 in the nonbreak control condition was analysed using within-person simple contrasts. Both Hypothesis 2 and 3 were tested with two GLMs (SPSS 24) as well. Two within-subject factors, the type of break and the time point of assessment, were defined. The type of break described the four consecutive rest-breaks interventions (control, unstructured break, exercise break, and relaxation break), the time point of assessment described the three assessments. One between-person factor, the rest-break sequence, described the allocation to the two classes. The outcome variables, vigor and fatigue, were entered into the model simultaneously. Within-person simple contrasts were calculated to determine the short-term effect (Assessment 1 to Assessment 2) and medium term effect (Assessment 1 to Assessment 3) of rest breaks as compared with the control condition without any break (Hypotheses 2a and 2b) or compared with the unstructured rest break (Hypotheses 3a and 3b). For testing Hypothesis 1, the level of significance was Bonferroni corrected (two variables) from  $p < 0.05$  to  $p < 0.025$ . For testing Hypothesis 2 and 3, the level of significance was Bonferroni-corrected (two comparisons \* two variables) from  $p < 0.05$  to  $p < 0.0125$ . Thus, by increasing the threshold for confirming a hypothesis, a conservative approach was adopted. Repeated-measures effect sizes (Morris & DeShon, 2002) were calculated for Assessments 1 and 2 as well as for assessment 1 and 3 for the nonbreak control condition. For the comparison of rest breaks with the nonbreak control condition and the unstructured rest break, effect sizes for studies with repeated measurements in both treatment and control groups were calculated (Morris, 2008). We consider effect sizes of  $d \geq 0.2$  as small,  $d \geq 0.5$  as medium, and  $d \geq 0.8$  as large effects (Cohen, 1992). To investigate the potential effect of the (slightly differing) rest-break times on outcomes, we additionally analysed the data using Generalized Estimating Equations (SPSS 24) to be able to include the durations of each rest break as covariate. Thereby, we calculated two models, predicting fatigue and vigor at Assessment 2 (Model 1) and Assessment 3 (Model 2), adding the corresponding Assessment 1 measure and rest-break duration as covariates and the type of break as factor.

## 3 | RESULTS

### 3.1 | Evaluating real-life implementation effects

First, we evaluated the effect of the differences in rest break time. The time between Assessments 1 and 2, including the duration of breaks

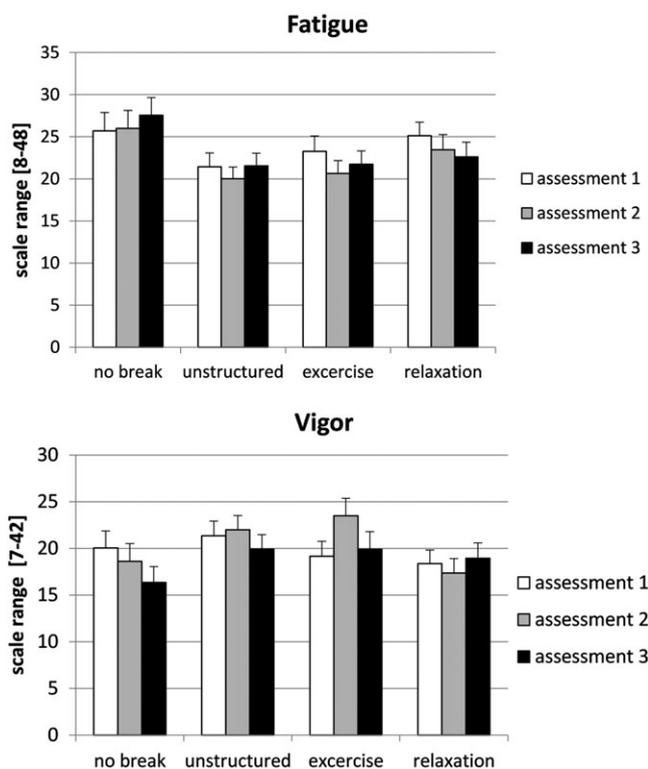
(where applicable), was 10.0 min for the no break and the unstructured break condition, 12.4 min for the active break, and 11.0 min for the relaxation break. The lecture time post break, including Assessment 3, varied between 19.0 and 20.8 min. However, the effects of rest-break duration on fatigue (Wald-Chi-Squared  $\chi^2[1, N = 264] = 1.56, p = 0.21$ ;  $\chi^2(1, N = 264) = 0.21, p = 0.65$ ) as well as vigor ( $\chi^2(1, N = 264) = 1.84, p = 0.18$ ;  $\chi^2(1, N = 264) = 0.25, p = 0.62$ ) at Assessments 2 and 3, respectively, were nonsignificant. Second, we evaluated whether the morning and the afternoon groups were comparable and thus could be analysed together. The groups did not differ in the overall level of fatigue ( $F(1, 64) = 2.81, p = 0.10$ ) or vigor ( $F(1, 64) = 2.45, p = 0.12$ ). Even though the groups also did not differ in the overall response to the breaks (break \* assessment \* group interaction) for vigor ( $F(6, 384) = 1.54, p = 0.17$ ), they did differ for fatigue ( $F(6, 384) = 2.54, p = 0.02$ ) because of a greater decrease in fatigue at Assessment 3 in the morning versus the afternoon group in the unstructured break ( $F(1, 64) = 10.38, p = 0.002$ ). In part, this is due to respective differences in the nonbreak control condition, with fatigue being higher but increasing less in the afternoon than in the morning. Despite of this difference, we considered the two groups to be comparable. Therefore, the following results are based on the combination of both groups. Third, we evaluated whether the experimental manipulations, that is, the three implemented rest-break conditions, were effective. Paired *t* tests were conducted comparing Assessments 1 and 2 to test their immediate effects on fatigue. During the unstructured break ( $T = 2.52, p = 0.01$ ) and the exercise break ( $T = 3.92, p < 0.001$ ), fatigue decreased significantly; during the relaxation break, the decrease of fatigue did not reach significance ( $T = 1.91, p = 0.06$ ), confirming that at least two of the three break conditions were effective in decreasing fatigue.

### 3.2 | Hypothesis 1

To test Hypothesis 1 (participating in class increases fatigue and decreases vigor), we analysed the change of fatigue and vigor during the no-break control condition (i.e., during uninterrupted class participation) as illustrated in Table 1 and Figure 2. In the 30 min between Assessment 1 and Assessment 3, fatigue increased ( $F(1, 64) = 11.80, p = 0.001$ ) and vigor decreased significantly ( $F(1, 64) = 45.99, p < 0.001$ ), thus supporting Hypothesis 1. The corresponding effect sizes were  $d = 0.44$  and  $d = -0.79$ , respectively, illustrating small to medium changes.

**TABLE 1** Means and standard deviations of assessment 1 (pre break) assessment 2 (post break) and assessment 3 (20 minutes post break)

Variable	Type of break	Time point of assessment					
		Assessment 1		Assessment 2		Assessment 3	
		M	SD	M	SD	M	SD
Fatigue	No break (control)	25.5	8.9	25.8	8.6	27.4	8.5
	Unstructured break	21.5	6.6	19.9	5.7	21.4	6.0
	Exercise break	23.3	7.3	20.6	6.1	21.7	6.4
	Relaxation break	24.9	6.8	23.3	7.3	22.3	7.4
Vigor	No break (control)	20.1	7.3	18.7	7.6	16.5	6.9
	Unstructured break	21.4	6.3	22.2	6.4	20.2	6.5
	Exercise break	19.1	6.4	23.5	7.5	20.0	7.6
	Relaxation break	18.5	6.0	17.4	6.3	19.2	7.0



**FIGURE 2** Means and 95% confidence intervals (error bars) of fatigue and vigor at Assessment 1 (pre), 2 (post), and 3 (20' post)

### 3.3 | Hypotheses 2 and 3

The univariate statistics of the GLM for repeated measures revealed a significant interaction between the type of break and the time point of assessment both for vigor ( $F(6, 384) = 17.82, p < 0.001$ ) and fatigue ( $F(6, 384) = 6.24, p < 0.001$ ), indicating that the four rest-break conditions, including the no-break control condition, significantly differed in their effect on the three assessment times. Thus, the use of simple contrasts to test Hypotheses 2 and 3 is warranted.

To test Hypotheses 2a and 2b (all three types of rest break will lead to an immediate and delayed decrease of fatigue and increase in vigor), the rest break conditions were compared with the nonbreak control condition, in which students continued classwork. All three types of breaks showed some effect on fatigue and vigor both at the end of the break (Assessment 2) as well as 20-minutes postbreak (Assessment 3), thus partly supporting Hypothesis 2 (Figure 2, Table 1, and Table 2). In particular, the unstructured rest break led to an increase in vigor (Assessment 2), which was sustained until 20 min after the break (Assessment 3). The corresponding effect sizes  $d = 0.31$  and  $d = 0.34$  were small. Fatigue remained unchanged. In comparison, the exercise break led to a large ( $d = 0.84$ ) and medium ( $d = 0.64$ ) increase in vigor and a small ( $d = -0.38, d = -0.44$ ) decrease of fatigue at Assessments 2 and 3, respectively. Finally, the relaxation break led to a medium decrease in fatigue ( $d = -0.58$ ) and a medium increase in vigor ( $d = 0.64$ ) at Assessment 3. To additionally investigate the effect of rest breaks on one especially relevant aspect of subjective task performance, "the ability to concentrate," we repeated this analysis for this single item. Although the

**TABLE 2** Comparison of the various break conditions using simple contrasts; level of significance was set to  $p < 0.0125$  (Bonferroni correction)

	Assessment	Fatigue		Vigor	
		$F(1, 64)$	$p$	$F(1, 64)$	$p$
No break—unstructured	1–2	5.92	0.018	8.38	0.005
	1–3	4.83	0.032	8.94	0.004
No break—exercise	1–2	13.58	<0.001	84.84	<0.001
	1–3	12.34	0.001	36.45	<0.001
No break—relaxation	1–2	5.24	0.025	0.25	0.620
	1–3	22.79	<0.001	17.69	<0.001
Unstructured—exercise	1–2	1.72	0.195	21.46	<0.001
	1–3	3.40	0.07	7.97	0.006
Unstructured—relaxation	1–2	0.08	0.785	4.20	0.044
	1–3	8.88	0.004	4.99	0.029

unstructured rest break neither showed an effect at Assessment 2 ( $F(1, 64) = 1.63, p = 0.21$ ) nor at Assessment 3 ( $F(1, 64) = 2.13, p = 0.15$ ) in comparison with the nonbreak condition, the exercise break improved the perceived ability to concentrate at Assessments 2 ( $F(1, 64) = 17.41, p < 0.001$ ) and 3 ( $F(1, 64) = 15.02, p < 0.001$ ) and the relaxation break at Assessment 3 ( $F(1, 64) = 13.21, p = 0.001$ ). With the exception of the unstructured break, this result mirrors the results for vigor.

To test Hypotheses 3a and 3b (breaks encompassing physical exercise or relaxation instructions will be more effective in decreasing fatigue and increasing vigor both immediately and with some delay), we compared the two active break conditions (exercise and relaxation) with the unstructured rest break. Both the exercise break and the relaxation break led to improvements of fatigue and vigor at some time points, thereby partly supporting Hypothesis 3. Compared with the unstructured rest break, the exercise break led to an additional medium ( $d = 0.57$ ) to small ( $d = 0.32$ ) increase in vigor at Assessments 2 and 3, respectively, but did not decrease fatigue beyond the unstructured break. The relaxation break was superior to the unstructured rest break in the additional small decrease of fatigue at Assessment 3 ( $d = -0.37$ ), all other effects being similar to the unstructured rest break.

## 4 | DISCUSSION

The primary aim of the present study was to investigate whether the known effect of a common (i.e., unstructured) rest break can be enhanced by specific rest-break activities known for their potential to acutely improve well-being. To this end, the effects of two rest-break activities, physical exercise, and relaxation practice were compared with those of an unstructured rest break. Outcome variables were fatigue and vigor, as these aspects of well-being are negatively affected by the demands of mental tasks and positively respond to instances of recovery (Hopstaken, 2015; Meijman, 1997; Zacher et al., 2014). We found that the unstructured rest break increased vigor on a short (i.e., immediately after the break) as well as medium-term (i.e., 20 min after the break) scale compared with the no-break control condition. However, the exercise break led to an additional short- and medium-term increase in vigor and the

relaxation break to an additional medium-term decrease in fatigue, thus illustrating that rest-break activities do indeed have the potential to enhance the effects of common, unstructured rest breaks.

A prerequisite for rest breaks to show an effect is that they are held in a demanding situation in which strain reactions, especially a draining of resources, are apparent. The present study was conducted with students during an academic class, which comprises a variety of mental tasks including sustained attention, recognizing or recalling knowledge, interpreting, analysing, or summarizing information and creating something new (Anderson & Krathwohl, 2001; Risko et al., 2012; Young et al., 2009). In addition, to keep focused on course requirements and inhibit mind wandering or engaging in nonacademic activities, students also have to exert self-control (Risko et al., 2012). Self-control has been found to be an additional source of work stress contributing to fatigue (Diestel & Schmidt, 2012; Schmidt & Diestel, 2015). This prerequisite for the investigation of rest break effects was fulfilled in the present study. During the 30-min nonbreak condition, where classwork was continued, the students showed a significant increase in fatigue and a decrease in vigor. Our finding corresponds to the increase of mental work load during academic lectures observed in a previous study (Young et al., 2009). This indicates that the mental work performed by the students was associated with strain reactions brought about by the demands of the task on hand.

The unstructured rest break, where individuals were free to do as they liked provided they stayed at their desks, led to a short- as well as medium-term improvement of vigor compared with the no-break condition. Fatigue did not change significantly. The improvement of vigor is in line with the effects of rest breaks on vigor and fatigue found in recent studies (Hunter & Wu, 2016; Zacher et al., 2014). The failure to find an effect of the unstructured rest break on fatigue is partly due to the conservative setting of the level of significance chosen to account for multiple measurements. On the other hand, the restriction of this rest break, to remain sitting at one's desk, possibly did not allow individuals to engage in activities that would have promoted recovery to a greater extent. However, having less autonomy regarding break activities may compromise their effects (Trougakos, Hideg, Cheng, & Beal, 2014). This is also suggested by a recent study showing that preferred break activities had the greatest effect on recovery (Hunter & Wu, 2016).

The exercise break, where individuals were instructed to do physical activity including jumping and stretching, showed short- to medium-term improvements in both vigor and fatigue compared with the nonbreak condition. This result corroborates previous findings on the effects of physical activity on fatigue. For example, a 10–15-min brisk walk was found to reduce feelings of tiredness (Watling et al., 2014) and increased feelings of energy (Thayer, 1987). In addition, low intensity exercise of short duration leads to immediate improvements of positive-activated affect (Reed & Ones, 2006). The exercise break was also superior to the unstructured rest break in increasing vigor. A comparable finding was made in one of the few studies investigating physically active rest breaks in an active work setting (office work), where physical activity compared with a passive rest break led to greater decreases in objective indicators of fatigue (Laporte, 1966).

The relaxation break, consisting of a guided relaxation exercise, also was superior to the unstructured rest break. Relative to the nonbreak condition, vigor was higher and fatigue was lower 20 min after the break. In direct comparison with the unstructured break, the relaxation break still showed a medium-term improvement in fatigue. Thus, the relaxation break led to a, albeit slightly delayed, decrease in fatigue. Relaxation is well-known for its immediate effects on anxiety and tense arousal (Meier & Welch, 2016; Pawlow & Jones, 2005). Less is known about the effects of relaxation on fatigue or vigor. Although some studies did not find relaxation to lead to an increase in energetic arousal (Meier & Welch, 2016; Saklofske et al., 1992), relaxation was found to increase vigor and decrease fatigue in other studies (Krajewski, Wieland, & Sauerland, 2010; Sianoja, Syrek, de Bloom, Korpela, & Kinnunen, 2017). The results of the present study indicate that a relaxation exercise may lead not to an immediate but to a *delayed* increase in vigor and decrease in fatigue.

The delayed effect of the relaxation break on an improvement of vigor and fatigue calls for some attention. Pre to post break, relaxation did not differ from the nonbreak condition in regard to vigor or fatigue, whereas the unstructured break led to an immediate improvement of vigor and physical activity led to an improvement of vigor and fatigue. At first glance, this may seem paradox as relaxation can be considered a low-effort activity, whereas physical activity is likely to be perceived as strenuous. However, precisely this strain of physical activity is associated with greater physical and therefore presumably also perceived arousal, thus affecting vigor and fatigue (Thayer, 1978). Relaxation, on the other hand, lowers physical and therefore perceived arousal. For example, progressive muscle relaxation was found to acutely increase sleepiness (Smith, Amutio, Anderson, & Aria, 1996). However, this dip in arousal seems to dissipate readily, unmasking the achieved recovery of fatigue/vigor at 20-min post break. Possibly, a postrelaxation activation activity, such as clenching one's fists, might eliminate this post relaxation dip.

#### 4.1 | Theoretical and practical implications

The main implication of the present study is that the effect of normal, unstructured rest breaks on well-being can be enhanced by the use of rest break activities such as physical activity and

relaxation instructions. Thus, the use of these strategies can surpass the reduction of fatigue and the increase of vigor achieved by temporarily relieving the individual from work demands, as is the aim of a standard rest break. Theoretically, this implies that a relief from work demands is not the only factor bringing about a reduction in mental fatigue, but that other factors may as well contribute to this aim. The greater increase in vigor and/or the greater reduction in fatigue seen in the exercise and relaxation breaks suggest that strategies aiming at improving well-being may encompass some of these other factors. As discussed, these could be a more pronounced relief of demands and induction of mental quiet as achieved by relaxation instructions or the increase of general and/or cortical arousal achieved by physical activity. As both relaxation as well as physical exercise readily elicit an improvement of mood, it may very well be that this shift towards positive mood fosters recovery, as has been suggested by the Broaden and Built Theory of Positive Emotions (Fredrickson, 2001). Though the precise mechanisms stand to debate, the results of the present study nevertheless imply that factors associated with mood regulation have the potential to affect fatigue and related factors on top of and in addition to the removal of work demands. This proposal is supported by recovery research, finding that the emotional experiences of recovery activities markedly affect their impact on well-being (Sonnentag, Venz, & Casper, 2017). Similar arguments have also been raised for vacations. As vacations have been found to improve well-being both for working as well as retired individuals, the respite from work demands cannot be the only factor accounting for these vacation effects (Strauss-Blasche et al., 2004).

The results of the present study also are encouraging for the practice of fatigue control during mentally demanding tasks. By administering a brief, 6–7-min relaxation technique or physical activity, the decrease of fatigue can be enhanced beyond the level of a normal rest break, with concomitant increases in vigor and thus potentially work engagement and productivity. Furthermore, the duration of improvements can be extended to at least 20-min post break and presumably longer. Thus, these measures would allow to effectively reduce fatigue during mentally demanding tasks. These findings are particularly valid in the context of academic courses, where short relaxation and/or exercise breaks may not only reduce fatigue but also enhance participation and learning during lectures (Risko et al., 2012). However, we assume that our findings are also valid for mentally demanding work outside the academic context. For example, similar lasting effects of relaxation exercises have previously been found for call center agents and knowledge workers (de Bloom et al., 2017; Krajewski et al., 2010). However, other studies have failed to find effects of relaxation and/or physical activity on fatigue for individuals engaged in mentally demanding work (Scholz et al., 2018).

#### 4.2 | Limitations and suggestions for further research

The following limitations of the present study need to be addressed. First, the present study solely relies on self-assessed well-being. This implies that the assessed aspects of well-being may be affected by

short-term variations in arousal, thus potentially incorrectly estimating the state of recovery. Indeed, a discrepancy between subjective awareness and objective assessment of sleepiness has, for example, been found after physical exercise in drivers (Watling et al., 2014). Second, the study was conducted in an academic teaching setting. Though an academic class imposes demands also found in other kinds of mental work, and both academic class work and office work lead to fatigue, office work and work in an academic class are obviously not identical. This warrants caution in generalizing the current findings to other contexts of mental work. Third, the unstructured rest break imposed some constraints on the individual, not to leave one's desk, which may have reduced its effect. In instances where the activities during rest breaks are at the individuals' discretion, they allow for a greater fulfillment of needs and thus potentially promote well-being to a greater extent (Van Hooff & Geurts, 2014). Thus, the unstructured rest break in the present study may underestimate the effect of (unstructured) rest breaks in real life. Fourth, the chosen duration of breaks is somewhat arbitrary. Though breaks of about 6-min duration have been found to be optimal in improving performance in mental tasks (Graf, 1922), the impact of the duration of rest breaks is still insufficiently understood (Lim & Kwok, 2016). Future studies will have to evaluate possible interactions between rest break activities and their duration. Fifth, the present study did not explicitly address the moderating effects of daily or seasonal cycles on rest-break effects, though such effects have been found (Boucsein & Thum, 1997; de Bloom et al., 2017; Kühnel, Zacher, de Bloom, & Bledow, 2017). Although our findings regarding differences between the unstructured morning and the afternoon break are in part in variance with other studies, group and/or course differences may account for this differences and not the time of day. Future studies will have to address this issue. Sixth, one of the two groups (third semester) had received some theoretical information about rest breaks in a course in the previous semester but had not heard anything about possible effects of rest-break activities. The other group (first semester) had not received any information on rest breaks. Even though prior knowledge may affect outcome, the negligible differences between the two groups make it unlikely that it significantly affected the results in the present study. Seventh, it has been shown that the mere assessment of well-being during mentally demanding tasks can reduce strain, thus potentially affecting outcomes (Schutte, 1999). However, as the present study used an identical assessment procedure for all four rest break conditions, we do not expect the assessment to differentially affect and thus distort the outcome of the present study. However, the increase of strain may have been underestimated due to the "time off" for assessments.

Future studies should extend the present findings to nonacademic contexts; modify the used rest-break activities by, for example, using different relaxation strategies or physical exercises; include other rest-break activities, such as brief mindfulness exercises (Tang et al., 2007) or a combination of rest-break activities (Matzer, Nagele, Lerch, Vajda, & Fazekas, 2017); and use additional outcome measures, especially physiological or performance related variables, as a reduction of fatigue through physical activity is not necessarily related to an improvement of performance (Watling et al., 2014).

## CONFLICT OF INTEREST

The authors have declared that they have no conflict of interest.

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